PESTICIDE SURFACE WATER AND SEDIMENT QUALITY REPORT

APRIL 1999 SAMPLING EVENT

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Pesticide Monitoring Project Report
April 1999 Sampling Event

Executive Summary

As part of the District's quarterly ambient monitoring program, unfiltered water and sediment samples from 36 sites were collected from April 19 to April 27, 1999 and analyzed for over sixty pesticides and/or products of their degradation. The herbicides ametryn, atrazine, bromacil, hexazinone, metribuzin, norflurazon, and simazine, along with the insecticides/degradates DDD, DDE, DDT, endosulfan sulfate, ethion, and heptachlor epoxide, were detected in one or more of these surface water samples. The ethion concentrations of 0.071 µg/L at S99 exceeds the 48 hour EC_{50} of 0.06 µg/L reported for *Daphnia magna*, a sensitive indicator species for aquatic macroinvertebrates. At this level, long term exposure can cause impacts to the macroinvertebrate populations, but the pulsed nature of agricultural runoff releases to the canal system precludes drawing any conclusions about long term average exposures. The DDT concentration of 0.0027 µg/L at G211 exceeds the FAC 62-302 Class III surface water quality standard of 0.001 µg/L. While such exceedances are generally associated with highly turbid waters suggestive of disturbed sediment, this was not observed in this case.

The herbicide ametryn, and the insecticides/degradates chlordane, DDD, DDE, DDT, endosulfan sulfate, and ethion were found in the sediment at several locations, along with one PCB compound. Some of the detected sediment concentrations of DDD, DDE, and DDT, are usually associated with the potential for impacting wildlife when compared to coastal sediment quality assessment guidelines. Chlordane and two of the DDD detections were of a magnitude considered to represent significant and immediate hazard to aquatic organisms. There are no corresponding freshwater sediment quality assessment guidelines, however. The compounds and concentrations found are typical of those expected from intensive agricultural activity.

Background and Methods

The District's pesticide monitoring network includes stations designated in the Everglades National Park Memorandum of Agreement, the Miccosukee Tribe Memorandum of Agreement, the Lake Okeechobee Operating Permit, and the non-Everglades Construction Project (non-ECP) permit. Surface waters are sampled quarterly and sediments semiannually.

Sixty-two pesticides and degradation products were analyzed for in samples from all of the 36 sites (Figure 1). The analytes, their respective minimum detection limits (MDL), and practical quantitation limits (PQL) are listed in Table 1. The reader is referred to the *Quality Assurance Evaluation* section of this report for a summary of any limitations on data validity that might influence the uses to which these data may be put. Each pesticide's description and possible uses and sites of application are taken from Hartley and Kidd (1987). The Florida Ground Water Guidance Concentrations (FDEP, 1994a) are listed to provide an indication at what level these pesticide residues could possibly impact human health, based on drinking water consumption or other routes of exposure (e.g., inhalation, ingestion of food residues, dermal uptake). Primary ground water standards are enforceable ground water standards, not screening tools or guidance levels. To evaluate the potential impacts on aquatic life, due to the pulsed nature of exposure,

the maximum observed concentration is compared to the Criterion Maximum Concentration published by the USEPA under Section 304 (a) of the Clean Water Act, if available, or the lowest EC_{50} or LC_{50} reported in the summarized literature. Sediment concentrations are compared to coastal sediment quality assessment guidelines (FDEP, 1994b), as there are no corresponding freshwater sediment quality assessment guidelines. This summary covers surface water and sediment samples collected between April 19 and April 27, 1999.

Findings and Recommendations

At least one pesticide was detected in the surface water and sediment at 36 and 18, of the 36 and 34 sites, respectively. Sediment samples are not collected at C51SR7 and CR33.5T. The concentrations of the pesticides detected at each of the sites are summarized for the surface water and sediment in Tables 2 and 3, respectively. The ethion surface water concentration of 0.071 µg/L at S99, exceeds the 48 hour EC_{50} of 0.06 µg/L, reported for *Daphnia magna,* a sensitive indicator species for aquatic macroinvertebrate (Figure 2). At this level, exposure can cause impacts to the macroinvertebrate populations. Since March 1995, eight out of eighteen sampling events had a detectable level of ethion. With the method detection limit around 0.02 µg/L, any detection will automatically exceed the calculated chronic toxicity (0.003 µg/L). Ethion was also detected in the sediment at S99 (3.6 µg/Kg). The DDT concentration of 0.0027 µg/L (G211) exceeds the FAC 62-302 Class III surface water quality standard of 0.001 µg/L. Previous detections of DDD and DDE were associated with field observations that the water samples contained significant suspended matter due to the strong flow. The suspended matter could provide a sink for additional residues, which are then removed by the whole water extraction process used by the lab. However for this event, the field notes for the G211 sampling location do not contain any references to significant suspended matter being present during the time of sampling. All these compounds have previously been detected in this monitoring program.

The above findings must be considered with the caveat that pesticide concentrations in surface water and sediment may vary significantly with relation to the timing and magnitude of pesticide application, rainfall events, pumping and other factors, and that this was only one sampling event. The possible long term or chronic toxicity impacts are also reported based on the single sampling event and do not take into account previous monitoring data.

Usage and Water Quality Impacts

Ametryn: Ametryn is a selective terrestrial herbicide registered for use on sugarcane, bananas, pineapple, citrus, corn, and non-crop areas. Most algal effects occur at concentrations > 10 µg/L (Verschueren, 1983). Environmental fate and toxicity data in Tables 4 and 5 indicate that ametryn (1) is lost from soil relatively easily by leaching, surface adsorption, and in surface solution; (2) is relatively non-toxic to mammals and fish; and (3) does not bioconcentrate significantly. Additional fish toxicity data includes a 96 hour LC_{50} of 14.1 mg/L for goldfish (Hartley and Kidd, 1987). The ametryn surface water concentrations found in this sampling event ranged from 0.011 to 0.029 µg/L. Using these criteria, these surface water levels should not have an acute, detrimental impact on fish or aquatic invertebrates. The sediment concentrations ranged from 17 to 24 µg/Kg. However, no sediment quality assessment guidelines have been developed for ametryn.

Atrazine: Atrazine is a selective systemic herbicide registered for use on pineapple, sugarcane, corn, rangelands, ornamental turf and lawn grasses, and non-crop areas. Environmental fate and toxicity data in Tables 4 and 5 indicate that atrazine (1) is easily lost from soil by leaching and in surface solution, with moderate loss from surface adsorption; (2) is relatively non-toxic to mammals and fish; and (3) does not bioconcentrate significantly. Additional fish toxicity data include a 96 hour LC_{50} of 76 mg/L for carp, 16 mg/L for perch and 4.3 mg/L for guppies (Hartley and Kidd, 1987). Also, in a flow-through bioassay, the maximum acceptable toxicant concentration (MATC) of atrazine was 90 and 210 µg/L for bluegill and fathead minnow (Verschueren, 1983). Atrazine inhibits cell multiplication of the alga, *Microcystis aeruginosa*, at 3 µg/L and most other biological effects occur at higher concentrations (Verschueren, 1983). The atrazine surface water concentrations found in this sampling event ranged from 0.012 to 1.0 µg/L. Using these criteria, these levels should not have an acute, detrimental impact on fish or aquatic invertebrates. Atrazine was not quantified in the sediment.

Bromacil: Bromacil is a terrestrial herbicide registered for use on pineapple, citrus, and non-crop areas. Environmental fate and toxicity data in Tables 4 and 5 indicate that bromacil (1) is easily lost from soil by leaching, with moderate loss from surface adsorption or surface solution; (2) is relatively non-toxic to mammals and fish; and (3) does not bioconcentrate significantly. Additional fish toxicity data includes a 96 hour LC_{50} of 164 mg/L for carp (Hartley and Kidd, 1987). The highest concentration of bromacil detected in the surface water during this sampling event was 0.089 µg/L. Using these criteria, these levels should not have an acute or chronic detrimental impact on fish. Bromacil was not quantified in the sediment.

Chlordane: Chlordane is a chlorinated hydrocarbon previously used as a contact insecticide. Environmental fate and toxicity data in Tables 4 and 5 indicate that chlordane (1) is moderately toxic to mammals and highly toxic to fish; and (2) has the potential for significant bioconcentration. Sediment quality assessment guidelines have been developed for several metals and organic compounds in coastal sediments (FDEP, 1994b). The threshold effects level (TEL) is 2.3 µg/kg and the probable effects level (PEL) is 4.8 µg/kg for chlordane in coastal sediments. However, an evaluation of the reliability of the sediment quality assessment guidelines for chlordane suggests a low degree of confidence can be placed on these guidelines due to the insufficient data to develop the guidelines. The detected sediment residue of 14 µg/kg at S38B, is usually or always associated with potential for impacting wildlife. While the use of this compound has been discontinued in recent years, its persistence and tendency to accumulate in sediments makes chlordane a compound of concern. Chlordane was not quantified in the surface water.

DDE, DDD, DDT: DDE is an abbreviation of **d**ichloro**d**iphenyldichloro**e**thylene [2,2-bis(4-chlorophenyl)-1,1-dichloroethene]. DDE is an environmental dehydrochlorination product of DDT (**d**ichloro**d**iphenyl**t**richloroethane), a popular insecticide for which the USEPA cancelled all uses in 1973. The large volume of DDT used, the persistence of DDT, DDE and another metabolite, DDD (**d**ichloro**d**iphenyl**d**ichloroethane), and the high K_{oc} of these compounds accounts for the frequent detections in sediments. The large hydrophobicity of these compounds also results in a significant bioaccumulation factor (Table 4). In sufficient quantities, these residues have reproductive effects in wildlife and carcinogenic effects in many mammals.

Sediment quality assessment guidelines have been developed for several metals and organic compounds in coastal sediments (FDEP, 1994b). The TEL is 2.1 μg/Kg and the PEL is 374 μg/Kg for DDE in coastal sediments. All but one of the DDE concentrations detected (1.5 to 190 μg/Kg) are between the TEL and PEL. The levels between the TEL and PEL have the possibility for impacting wildlife as they have exceeded the threshold level. The 1.5 μg/Kg value, which is below the TEL, should not have an impact on wildlife.

The DDD concentrations detected range from 1.5 to 91 μg/Kg. These values, which are between the TEL (1.2 μg/Kg) and PEL (7.8 μg/Kg), also have the possibility for impacting wildlife. Two of the values (12 μg/Kg at S177 and 91 μg/Kg at S6) exceed the PEL and are considered to represent significant and immediate hazard to aquatic organisms.

The only DDT concentration detected (1.9 μg/Kg at S177) falls between the TEL (1.2 μg/Kg) and PEL (4.8 μg/Kg). This level has the possibility for impacting wildlife.

This was the fourth and second time DDE and DDD, respectively, have been quantified in surface waters, while DDT has been detected for the first time. The lower MDL for DDE, DDD, and DDT (i.e., 0.02 to 0.002 μg/L) could account for the surface water detections. Previous residues at this level would have gone undetected. Also, for the previous sampling events, all the water samples contained significant suspended matter due to the strong flow. The suspended matter could provide a sink for additional residues, which are then removed by the whole water extraction process used by the lab. However for this event, the field notes for the G211 sampling location do not contain any references to significant suspended matter being present during the time of sampling. The DDT concentration of 0.0027 μg/L exceeds the FAC 62-302 Class III surface water quality standard of 0.001 μg/L.

Endosulfan sulfate: Endosulfan sulfate is an oxidation metabolite of the insecticide endosulfan. The water solubility and Henry's constant indicate that endosulfan sulfate is less volatile than water and concentrations will increase as water evaporates (Lyman et al., 1990). Endosulfan sulfate has a relatively high degree of accumulation in aquatic organisms (Table 4). The surface water and sediment concentrations detected in this sampling event were 0.0025 μg/L (G211) and 15 μg/Kg (S178), respectively. No FDEP surface water standard (FAC 62-302) has been promulgated for endosulfan sulfate, nor does this concentration exceed the Florida Class III surface water quality standard of 0.056 μg/L, for the parent compound, endosulfan. No surface water residues of endosulfan or endosulfan sulfate were detected at S178 (Figure 3). No sediment quality assessment guidelines have been developed for endosulfan sulfate.

Ethion: Ethion is a non-systemic acaricide and insecticide registered for use on several fruits, citrus, and vegetables. Environmental fate and toxicity data in Tables 4 and 5 indicate that ethion (1) is strongly sorbed to soil and therefore can accumulate in sediments; (2) is slightly toxic to mammals, relatively toxic to fish and extremely toxic to Daphnia; and (3) bioconcentrates to a limited extent. Several sources of toxicity information have shown both agreement and disagreement of these laboratory tests. The ethion surface water concentration of 0.071 μg/L at S99, exceeds the 48 hour EC_{50} of 0.06 μg/L, reported for *Daphnia magna*, a

sensitive indicator species for aquatic macroinvertebrate (Figure 2). At this level, exposure can cause impacts to the macroinvertebrate populations. Since March 1995, eight out of eighteen sampling events had a detectable level of ethion. With the method detection limit around 0.02 µg/L, any detection will automatically exceed the calculated chronic toxicity (0.003 µg/L). Ethion was also detected in the sediment at S99 (3.6 µg/Kg). However, no sediment quality assessment guidelines have been developed for ethion.

Heptachlor epoxide: Heptachlor epoxide is the oxidation product of the insecticide heptachlor. All registrations of heptachlor were cancelled in 1987 due to its potential carcinogenicity. Heptachlor was registered for use in the control of termites, ants, and soil insects. Heptachlor epoxide is resistant to chemical and biological transformations in aquatic environments, and half-lives of over several years are probable (Callahan et al., 1979). Heptachlor epoxide has not been detected in the surface water, but the last sediment detection was in 1988.

Hexazinone: Hexazinone is a non-selective contact herbicide that inhibits photosynthesis. Registered uses include sugarcane, pineapple, and non-crop areas. Environmental fate and toxicity data in Tables 4 and 5 indicate that hexazinone (1) is easily lost from soil by leaching, with moderate loss from surface adsorption or surface solution; (2) is relatively non-toxic to mammals and fish; and (3) does not bioconcentrate significantly. Hexazinone is practically non-toxic to freshwater invertebrates with an EC_{50} of 145 mg/l for *Daphnia magna* (U.S. Environmental Protection Agency, 1988). The only surface water concentration found in this sampling event (0.039 µg/L at S140) should not have an acute impact on fish or aquatic invertebrates. Hexazinone was not detected in the sediment.

Metribuzin: Metribuzin is a selective systemic herbicide used on a variety of crops including potatoes, tomatoes, sugarcane, and peas. Environmental fate and toxicity data in Tables 4 and 5 indicate that metribuzin (1) has a large potential for loss due to leaching, a medium potential for loss in surface solution, and a small potential for loss due to surface adsorption; (2) is relatively non-toxic to mammals and fish; and (3) does not bioaccumulate significantly. The only concentration of metribuzin detected was 0.031 µg/L. Using these criteria, this surface water level should not have an acute impact on fish or aquatic invertebrates. No metribuzin was detected in the sediment.

Norflurazon: Norflurazon is a selective herbicide registered for use on many crops including citrus. Environmental fate and toxicity data in Tables 4 and 5 indicate that norflurazon (1) is easily lost from soil surface solution and a moderate potential for loss due to leaching and surface adsorption; (2) is relatively non-toxic to mammals and fish; and (3) does not bioconcentrate significantly. The LC_{50} for norflurazon is >200 mg/L for catfish and goldfish (Hartley and Kidd, 1987). The norflurazon surface water concentrations ranged from 0.045 to 0.46 µg/L. Even at the highest concentration, this is over two orders of magnitude below the calculated chronic action level. Using these criteria, these levels should not have an acute, detrimental impact on fish or aquatic invertebrates.

PCBs: Polychlorinated biphenyls (PCBs) is the generic term for a group of 209 congeners that contain a varying number of substituted chlorine atoms on one or both of the biphenyl rings.

PCB-1254 is a commercial grade mixture containing 54% chlorine by weight. Production of PCBs was banned in 1978 and closed system uses are being phased out. In natural water systems, PCBs are found primarily sorbed to suspended sediments due to the very low solubility in water (Callahan et al., 1979). The tendency of PCBs for adsorption increases with the degree of chlorination and with the organic content of the adsorbent. Florida sediment quality assessment guidelines has been developed for total PCBs in coastal sediments (FDEP, 1994b). However, an evaluation of the reliability of the sediment quality assessment guidelines for total PCBs suggests a low degree of confidence can be placed on these guidelines due to the insufficient data used in their development. While the production ban, phase out of uses, and stringent spill clean-up requirements have significantly reduced environmental loadings in recent years, the persistence and tendency to accumulate in sediment and bioaccumulate in fish, make this class of organochlorine compounds especially problematic. The TEL is 21.6 μg/Kg and the PEL 189 μg/Kg for PCB's. The sediment residue detected at S79 of 130 μg/Kg, is similar to the concentration detected during the previous (January) sampling event at this same location. A value below the TEL should not have an impact on wildlife. The value between the TEL and PEL has a possibility for impacts, while those exceeding the PEL have the potential for impacting wildlife. None of the PCB congeners were detected in the surface water.

Simazine: Simazine is a selective systemic herbicide registered for use on many crops including sugarcane, citrus, corn, and non-crop areas. Environmental fate and toxicity data in Tables 4 and 5 indicate that simazine (1) is easily lost from soil by leaching and has a moderate potential for loss due to surface adsorption and surface solution; (2) is relatively non-toxic to mammals and fish; and (3) does not bioconcentrate significantly. Additional fish toxicity data include a 96 hour LC_{50} of 49 mg/L for guppies (Hartley and Kidd, 1987). Most of the aquatic biological effects occur at concentrations > 500 μg/L (Verschueren, 1983). Aquatic invertebrate LC_{50} toxicity ranges from 3.2 mg/L to 100 mg/L for simazine (U.S. Environmental Protection Agency, 1984). The highest surface water concentration of simazine found in this sampling event was 0.089 μg/L, far below any level of concern for fish or aquatic invertebrates.

Quality Assurance Evaluation

Four duplicate samples were collected at sites S31, S18C, S6, and S78. All the analytes detected in the surface water had precision ≤30% RPD. No analytes were detected in the field blank collected at S6. However, the field blank collected at S18C contained alpha-BHC, at a concentration of 0.0019 ug/L. No alpha-BHC residues were detected in the ambient samples. No analytes were detected in the two equipment blanks performed at S18C and G94D. All samples were shipped and all bottles were received.

Due to matrix interference, the endosulfan sulfate surface water and endosulfan sediment MDLs were elevated at S178. Low concentrations of representative analytes from each pesticide group/method were added to laboratory water as well as to samples submitted. The matrix spike recoveries and precision for atrazine were not assessed due to the high content of this parameter in the spiked sample for the following sample locations: S2, S3 S4, S235, S79, CR33.5T, S78, (including field duplicate), FECSR78, S65E, S191, S99, and S80. Comparisons are based on the FDEP Comprehensive Quality Assurance Plan targets for precision and accuracy. Organic quality assurance targets are set according to historically generated data or are adapted from the

U.S. Environmental Protection Agency with slight modifications or internal goals, based on FDEP limited data. Parameters with low or high recoveries indicate that the sample matrix interferes with these analyses and interpretation of the respective analytical results should consider this effect. It has recently been brought to the attention of the Pesticide Program Manager that the sample collection procedure for pesticides employed a triple rinsing of the sample bottles, a procedure which has the potential for biasing the ambient concentration higher, relative to what would be representative of the surface water sample. The bias is based on the contention that the analytical laboratory performs a whole sample extraction and a solvent rinse of the bottle inner surface. This situation is currently being investigated.

Glossary

LD_{50}: The dosage which is lethal to 50% of the terrestrial animals tested within a short (acute) exposure period, usually 24 to 96 hours.

LC_{50}: A concentration which is lethal to 50% of the aquatic animals tested within a short (acute) exposure period, usually 24 to 96 hours.

EC_{50}: A concentration necessary for 50% of the aquatic species tested to exhibit a toxic effect short of mortality (e.g., swimming on side or upside down, cessation of swimming) within a short (acute) exposure period, usually 24 to 96 hours.

Koc: The soil/sediment partition or sorption coefficient normalized to the fraction of organic carbon in the soil. This value provides an indication of the chemical's tendency to partition between soil organic carbon and water.

Bioconcentration Factor:
The ratio of the concentration of a contaminant in an aquatic organism to the concentration in water, after a specified period of exposure via water only. The duration of exposure should be sufficient to achieve a near steady-state condition.

Soil or water half-life:
The time required for one-half the concentration of the compound to be lost from the water or soil under the conditions of the test.

MDL: The minimum concentration of an analyte that can be detected with 99% confidence of its presence in the sample matrix.

PQL: The lowest level of quantitation that can be reliably achieved within specified limit of precision and accuracy during routine laboratory operating conditions. The PQL is further verified by analyzing spike concentrations whose relative standard deviation in 20 fortified water samples is < 15%. In general, the PQL is 2 to 5 times larger than the MDL.

TEL: The threshold effects level represents the upper limit of the range of sediment contaminant concentrations dominated by no effect data entries, or the minimal effects

range. Within this range, concentrations of sediment-associated contaminants are not considered to represent significant hazards to aquatic organisms

PEL: The probable effects level was calculated to define the lower limit of the range of contaminant concentrations that are usually or always associated with adverse biological effects or the lower limit of the probable effects range. Within the probable effects range, concentrations of sediment-associated contaminants are considered to represent significant and immediate hazards to aquatic organisms.

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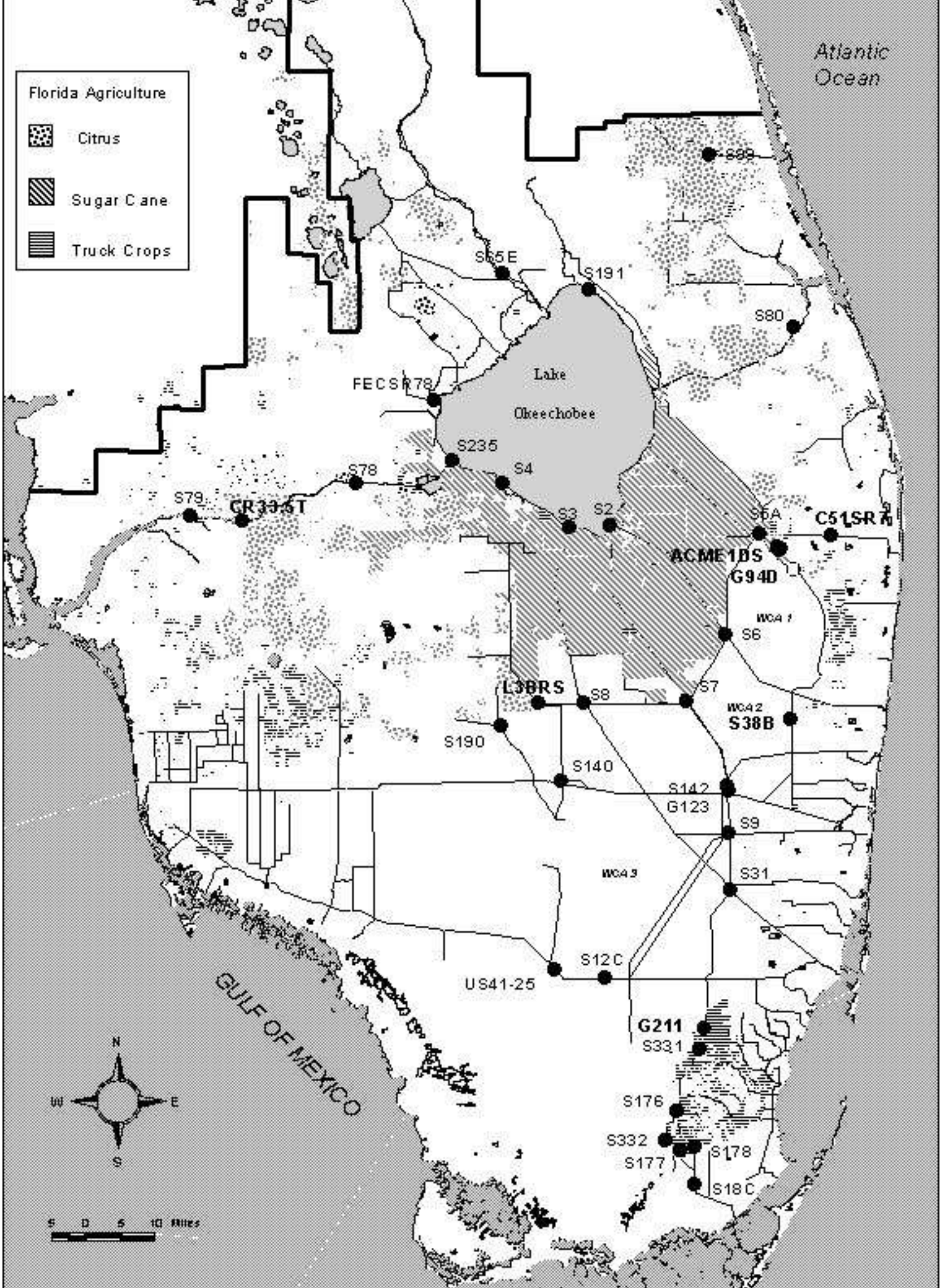
Florida Agriculture
Citrus
Sugar Cane
Truck Crops
Atlantic Ocean
S80
S191
S155E
FECSR78
Lake Okeechobee
S235
S4
S78
S79
CR336T
S3
S2
S6A
C51SR7
ACME1DS
G94D
WCA 1
S6
L38RS
S8
S7
WCA 2
S38B
S190
S140
S142
G123
S9
WCA 3
S31
S12C
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S332
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S177
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Table 1. Minimum detection limits (MDL) and practical quantitation limits (PQL) for pesticides determined in April 1999.

Pesticide	Water range of MDL-PQL (µg/L)	Sediment range of MDL-PQL (µg/Kg)	Pesticide	Water range of MDL-PQL (µg/L)	Sediment range of MDL-PQL (µg/Kg)
2,4-D	2 – 4	35 - 740	endrin	0.0019 - 0.0098	1.8 – 66
2,4,5-T	2 – 4	35 - 740	endrin aldehyde	0.0019 - 0.0098	0.88 – 33
2,4,5-TP (silvex)	2 – 4	35 - 740	ethion	0.019 - 0.098	2 – 83
alachlor	0.047 - 0.25	13- 500	ethoprop	0.019 - 0.098	4.1 – 170
aldrin	0.00094- 0.0049	0.5 - 17	fenamiphos (nemacur)	0.028 – 0.15	13 –500
ametryn	0.0094 - 0.049	2 – 83	fonofos (dyfonate)	0.019 - 0.098	4.1 – 83
atrazine	0.0094 - 0.049	2 – 83	heptachlor	0.00094- 0.0049	0.5 – 17
azinphos methyl (guthion)	0.019 – 0.098	8.4 – 330	heptachlor epoxide	0.00094 - 0.0098	0.5 - 17
α-BHC (alpha)	0.00094 - 0.0049	0.5 - 17	hexazinone	0.019 – 0.098	8.4 – 330
β-BHC (beta)	0.0019 - 0.098	0.5 - 17	imidacloprid	0.4 – 0.8	ND
δ-BHC (delta)	0.00094- 0.0049	0.88 – 33	linuron	0.4 - 0.8	8.4 – 130
γ-BHC (gamma) (lindane)	0.00094 - 0.0049	0.5 - 17	malathion	0.028 - 0.15	6.3 –170
bromacil	0.038 – 0.2	12 –500	metalaxyl	0.057 – 0.29	1.3 – 66
butylate	0.019 - 0.098	ND	methamidophos	ND	42 – 660
carbophenothion (trithion)	0.028- 0.029	1.3 – 66	methoxychlor	0.0038 –0.039	2.1 – 130
chlordane	0.0094 – 0.098	6.3 - 330	metolachlor	0.047 – 0.25	21 – 500
chlorothalonil	0.019 - 0.02	0.88 – 66	metribuzin	0.019 – 0.098	8.4 – 330
chlorpyrifos ethyl	0.019 - 0.098	4.1 – 170	mevinphos	0.038 – 0.2	10 –430
chlorpyrifos methyl	0.019 - 0.098	4.1 – 170	mirex	.0019 - 0.0098	0.88 – 33
cypermethrin	0.0047 - 0.049	ND	monocrotophos (azodrin)	ND	84 – 1300
DDD-p,p’	0.0019 - 0.0098	0.88 – 33	naled	0.075 – 0.39	34 –500
DDE-p,p’	0.0019 - 0.0098	0.88 – 33	norflurazon	0.028 – 0.15	13 –500
DDT-p,p’	0.0019 - 0.0098	1.3 – 33	parathion ethyl	0.019 – 0.098	4.1 – 170
demeton	0.094 – 0.49	42 –1700	parathion methyl	0.019 – 0.098	4.1 – 170
diazinon	0.019 - 0.098	4.1 – 83	PCB	0.019 – 0.098	8.8 –500
dicofol (kelthane)	0.019 - 0.039	0.88 – 130	permethrin	0.047 - 0.02	ND
dieldrin	0.0019 - 0.0049	0.5 - 17	phorate	0.028 - 0.15	4.1 – 83
disulfoton	0.028 - 0.15	6.3 - 170	prometryn	0.019 - 0.098	4.1 – 170
diuron	0.4 - 0.8	8.4 – 130	simazine	0.019 - 0.098	2.1 – 83
α-endosulfan (alpha)	0.0019 - 0.0098	0.5 – 17	toxaphene	0.071 – 0.29	31 –1000
β-endosulfan (beta)	0.0019 - 0.0098	0.5 – 17	trifluralin	0.0094 - 0.0098	1.6 - 66
endosulfan sulfate	0.0019 - 0.0098	0.88 - 33			

Table 2. Summary of pesticide residues above the method detection limit found in water samples collected by SFWMD in April 1999

DATE	SITE	FLOW	COMPOUNDS (ug/L)													Number of compounds detected at site
			ametryn	atrazine	bromacil	DDD-P,P	DDE-P,P	DDT-P,P	endosulfan sulfate	ethion	heptachlor epoxide	hexazinone	metribuzin	norflurazon	simazine	
4/19/99	S18C	Yes	-	0.012 I*	-	-	-	-	-	-	-	-	-	-	-	1
	S178	No	-	0.014 I	-	-	-	-	-	-	-	-	-	-	-	1
	S177	Yes	-	0.40 I	-	-	-	-	-	-	-	-	-	-	-	1
	S332	Yes	-	0.014 I	-	-	-	-	-	-	-	-	-	-	-	1
	S176	Yes	-	0.051	-	-	-	-	-	-	-	-	-	-	-	1
	S331	Yes	-	0.055	-	-	-	-	-	-	-	-	-	-	-	1
	G211	Yes	-	0.059	-	0.0065 I	0.0058 I	0.0027 I	0.0025 I	-	0.0010 I	-	-	-	-	6
4/20/99	US41-25	Yes	-	0.014 I	-	-	-	-	-	-	-	-	-	-	-	1
	S12C	No	-	0.019 I	-	-	-	-	-	-	-	-	-	-	-	1
	S31	No	-	0.30 *	-	-	-	-	-	-	-	-	-	-	-	1
	S9	No	-	-	-	-	-	-	-	-	-	-	-	-	-	0
	G123	No	-	0.27	-	-	-	-	-	-	-	-	-	-	-	1
4/21/99	S142	Yes	0.020 I	0.34	-	-	-	-	-	-	-	-	-	-	-	2
	38B	No	0.014 I	1.0	-	-	-	-	-	-	-	-	-	-	-	2
	S140	No	-	0.10	-	-	-	-	-	-	-	0.039 I	-	-	-	2
	S190	No	-	0.048	-	-	-	-	-	-	-	-	-	0.097 I	-	2
	L3BRS	No	0.013 I	0.42	-	-	-	-	-	-	-	-	-	-	-	2
	S8	No	0.011 I	0.36	-	-	-	-	-	-	-	-	-	-	-	2
	S7	No	0.018 I	0.38	-	-	-	-	-	-	-	-	-	-	-	2
	S6	No	0.013 I*	0.29 *	-	-	-	-	-	-	-	-	-	-	-	2
4/22/99	S5A	Yes	-	0.21	-	-	-	-	-	-	-	-	-	-	-	1
	G94D	Yes	0.012 I	0.22	-	-	-	-	-	-	-	-	-	-	-	2
	ACME1DS	No	0.018 I	0.21	-	-	-	-	-	-	-	-	-	-	-	2
4/26/99	C51SR7	Yes	0.022 I	0.41	-	-	-	-	-	-	-	-	-	-	0.025 I	3
	S2	No	0.015 I	0.38	-	-	-	-	-	-	-	-	-	-	0.023 I	3
	S3	No	-	0.32	-	-	-	-	-	-	-	-	-	-	-	1
	S4	No	0.016 I	0.41	-	-	-	-	-	-	-	-	-	-	0.023 I	3
	S235	Reverse	0.016 I	0.37	-	-	-	-	-	-	-	-	-	-	0.020 I	3
	S79	No	0.029 I	0.37	-	-	-	-	-	-	-	-	0.031 I	0.045 I	-	4
	CR33.5T	Reverse	0.016 I	0.33	-	-	-	-	-	-	-	-	-	0.053 I	-	3
	S78	Yes	0.015 I*	0.37 *	-	-	-	-	-	-	-	-	-	-	-	2
4/27/99	FECSR78	No	-	0.13	-	-	-	-	-	-	-	-	-	-	-	1
	S65E	Yes	-	0.058	-	-	-	-	-	-	-	-	-	-	-	1
	S191	No	-	0.056	0.068 I	-	-	-	-	-	-	-	-	-	-	2
	S99	No	-	-	0.089 I	-	-	-	-	0.071 I	-	-	-	0.46	0.089 I	4
	S80	Yes	-	-	-	-	-	-	-	-	-	-	-	-	0.027 I	1
Total number of compound detections			15	33	2	1	1	1	1	1	1	1	1	4	6	

- denotes that the result is below the MDL; * - results are the average of duplicate samples; I - value reported is less than the minimum quantitation limit, and greater than or equal to the minimum detection limit;

Table 3. Summary of pesticide residues above the method detection limit found in sediment samples collected by SFWMD in April 1999

DATE	SITE	COMPOUNDS (µg/Kg)								Number of compounds detected at site
		ametryn	chlordane	DDD	DDE	DDT	endosulfan sulfate	ethion	PCB-1254	
4/19/99	S178	-	-	-	73	-	15	-	-	2
	S177	-	-	12	65	1.9 I	-	-	-	3
	S331	-	-	-	1.5 I	-	-	-	-	1
	G211	-	-	-	4.1	-	-	-	-	1
4/20/99	S31	-	-	-	16 *	-	-	-	-	1
4/21/99	S142	-	-	-	21	-	-	-	-	1
	S38B	-	14 I	-	-	-	-	-	-	1
	S7	17 I	-	-	-	-	-	-	-	1
	S6	22 I *	-	91 *	190 *	-	-	-	-	3
4/22/99	S5A	-	-	2.8 I	7.3	-	-	-	-	2
	G94D	-	-	2.1 I	10	-	-	-	-	2
4/26/99	S2	-	-	5.1 I	19	-	-	-	-	2
	S3	-	-	1.5 I	7.4	-	-	-	-	2
	S4	24 I	-	5.3 I	34	-	-	-	-	3
	S79	-	-	-	9.5 I	-	-	-	130 I	2
	S78	-	-	-	4.1 I *	-	-	-	-	1
4/27/99	S80	-	-	-	5.9 I	-	-	-	-	1
	S99	-	-	-	-	-	-	3.6 I	-	1
Total number of compound detections		3	1	7	15	1	1	1	1	

- denotes that the result is below the MDL; * - results are the average of duplicate samples; I - value reported is less than the minimum quantitation limit, and greater than or equal to the minimum detection limit

Table 4. Selected properties of pesticides found in the April 1999 sampling event.

Common name	FDEP Surface Water Standards 62-302 (µg/L)	Florida Ground Water Guidance Conc. (µg/L)	LD_{50} acute rats oral (mg/Kg) (1)	EPA carcinogenic potential	Water Solubility (mg/L) (2, 3)	Koc (ml/g) (2, 3)	soil half-life (days) (2, 3)	SCS rating (2) LE	SA	SS	Bioconcentration Factor (BCF)
Ametryn	-	63	1,110	D	185	300	60	M	M	M	33
Atrazine	-	3**	3,080	C	33	100	60	L	M	L	86
Bromacil	-	90	5,200	C	700	32	60	L	M	M	15
Chlordane	0.0043	2**	365-590	B2	0.056	3,800	-	-	-	-	3,141
DDD, p,p'	-	0.1	3,400	-	0.055	239,900	-	-	-	-	3,173
DDE, p,p'	-	0.1	880	-	0.065	243,220	-	-	-	-	2,887
DDT, p,p'	0.001	0.1	113	-	0.00335	140,000	-	-	-	-	15,377
Endosulfan sulfate	-	0.3	-	-	0.117	-	-	-	-	-	2,073
Ethion	-	3.5	208	-	1.1	8,900	150	S	L	M	586
Heptachlor epoxide	-	0.2**	-	B2	0.275	-	-	-	-	-	1,280
Hexazinone	-	231	1,690	D	33,000	54	90	L	M	M	2
Metribuzin	-	175	2,200	D	1,220	41	30	L	S	M	11
Norflurazon	-	280	9,400	C	28	700	90	M	M	L	94
PCB	0.014	0.5**	-	B2	-	-	-	-	-	-	-
Simazine	-	4**	>5,000	C	6.2	130	60	L	M	M	221

SCS Ratings are pesticide loss due to leaching (LE), surface adsorption (SA) or surface solution (SS) and grouped as large (L), medium (M), small (S) or extra small (XS)
Bioconcentration Factor (BCF) calculated as BCF = 10^(2.791 - 0.564 log WS) (4)
B2: probable human carcinogen; C: possible human carcinogen; D: not classified; E: evidence of non-carcinogen for humans (5)
FDEP surface water standards (12/96) for Class III water except Class I in ( )
**primary standard

(1) Hartley, D. and H. Kidd. (Eds.) (1987). The Agrochemicals Handbook. Second Edition, The Royal Society of Chemistry. Nottingham, England.
(2) Goss, D. and R. Wauchope. (Eds.) (1992). The SCS/ARS/CES Pesticide Properties Database: II Using It With Soils Data In A Screening Procedure. Soil Conservation Service. Fort Worth, TX.
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(4) Lyman, W.J., W.F. Reehl, and D.H. Rosenblatt. (1990). Handbook of Chemical Property Estimation Methods. American Chemical Society, Washington, DC.
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Table 5. Toxicity of pesticides found in the April 1999 sampling event to selected freshwater aquatic invertebrates and fishes (ug/L).

common name	48 hr EC_{50} Water flea *Daphnia Magna*		acute toxicity (*)	chronic toxicity (*)	96 hr LC_{50} Fathead Minnow (#) *Pimephales Promelas*		acute toxicity	chronic toxicity	96 hr LC_{50} Bluegill *Lepomis macrochirus*		acute toxicity	chronic toxicity	96 hr LC_{50} Largemouth Bass *Micropterus salmoides*		acute toxicity	chronic toxicity	96 hr LC_{50} Rainbow Trout (#) *Oncorhynchus mykiss*		acute toxicity	chronic toxicity	96 hr LC_{50} Channel Catfish *Ictalurus punctatus*		acute toxicity	chronic toxicity
ametryn	28,000	(7)	9,333	1,400	-		-	-	4,100	(5)	1,367	205	-		-	-	8,800	(5)	2,933	440	-		-	-
atrazine	6,900	(7)	2,300	345	15,000	(7)	5,000	750	16,000	(5)	5,333	800	-		-	-	8,800	(5)	2,933	440	7,600	(5)	2,533	380
bromacil	-		-	-	-		-	-	127,000	(7)	42,333	6,350	-		-	-	36,000	(7)	12,000	1,800	-		-	-
chlordane	-		-	-	-		-	-	70	(6)	23	3.5	-		-	-	90	(6)	30	5	-		-	-
DDD,p,p'	3,200	(8)	1,067	0.04	4,400	(1)	1,467	220	42	(1)	14	2.1	42	(1)	14	2.1	70	(1)	23.3	3.5	1,500	(1)	500	75
DDE,p,p'	-		-	-	-		-	-	240	(1)	80	12	-		-	-	32	(1)	10.7	1.6	-		-	-
DDT,p,p'	-		-	-	19	(6)	6.3	0.95	8	(6)	2.7	0.4	2	(6)	0.7	0.10	7	(6)	2.3	0.35	16	(6)	5.3	0.8
endosulfan	166	(7)	55	8	1	(1)	0.3	0.05	1	(1)	0.33	0.05	-	(1)	-	-	1	(1)	0.33	0.050	1	(1)	0.3	0.05
	-		-	-	-		-	-	2	(3)	0.67	0.10	-		-	-	3	(2)	1	0.15	1.5	(7)	0.5	0.08
	-		-	-	-		-	-	-		-	-	-		-	-	1	(3)	0.33	0.050	-		-	-
	-		-	-	-		-	-	-		-	-	-		-	-	0.3	(6)	0.10	0.015	-		-	-
ethion	0.06	(1)	0.02	0.003	720	(1)	240	36	210	(1)	70	11	173	(1)	58	9	500	(1)	167	25	7,600	(1)	2,533	380
	-		-	-	-		-	-	13	(3)	4.3	0.65	150	(4)	50	8	193	(3)	64	10	7,500	(4)	2,500	375
	-		-	-	-		-	-	22	(4)	7.3	1.1	-		-	-	560	(4)	187	28	-		-	-
heptachlor epoxide	-		-	-	-		-	-	5.3	(9)	1.8	0.3	-		-	-	20	(9)	7	1	-		-	-
hexazinone	151,600	(7)	50,533	7,580	274,000	(5)	91,333	13,700	100,000	(7)	33,333	5,000	-		-	-	180,000	(7)	60,000	9,000	-		-	-
metribuzin	4,200	(7)	1,400	210	-		-	-	80,000	(5)	26,667	4,000	-		-	-	64,000	(5)	21,333	3,200	1,000,000	(7)	33,333	5,000
norflurazon	15,000	(7)	5,000	750	-		-	-	16,300	(7)	5,433	815	-		-	-	8,100	(7)	2,700	405	>200,000	(5)	>67,000	>10,000
simazine	1,100	(7)	367	55	100,000	(7)	33,333	5,000	90,000	(5)	30,000	4,500	-		-	-	100,000	(7)	33,333	5,000	-		-	-

(*) Florida Administrative Code (FAC) 62-302.200, for compounds not specifically listed, acute and chronic toxicity standards are calculated as one-third and one-twentieth, respectively, of the amount lethal to 50% of the test organisms in 96 hours, where the 96 hour LC_{50} is the lowest value which has been determined for a species significant to the indigenous aquatic community.

(#) Species is not indigenous. Information is given for comparison purposes only.

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Figure 2. Ethion Concentration in Surface Water at S99

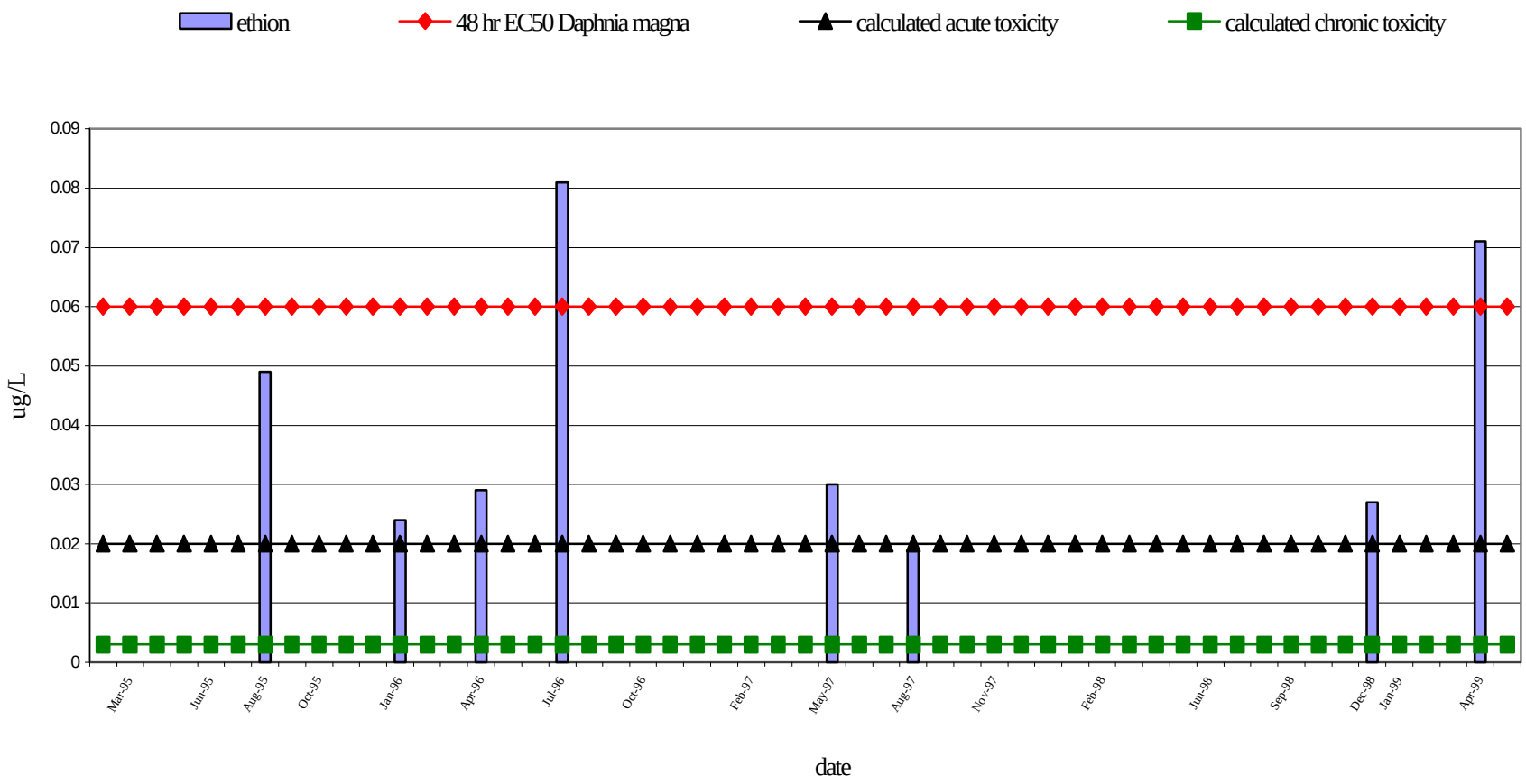

Figure 3. Endosulfan Concentration in Surface Water at S178